

What to do With Chronically Sick Animals?  
A Study of Pastoralists' Decision-Making in the Far North Region of Cameroon

Research Thesis

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by

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## **ABSTRACT**

Previous literature has found that the long-term goal of African pastoralists is the healthy, longevity of the herd. However, herders in the Far North Region, Cameroon, do not always remove sick animals from their herds, which seems in direct opposition to this long-term goal. Diseases endemic to the region, such as Brucellosis, have the potential to cause fertility problems for the herd and are highly contagious. Using an ethnographic approach to capture the herders' perspective on disease and fertility, semi-structured interviews were conducted with sedentary and mobile herders to better understand why herders decide not to sell sick animals and if disease management strategies among Far North Region pastoralists have an impact on herd fertility. Biological samples taken in the two previous years and basic demographic information collected during the interviews were compared against ethnographic information provided by the herders in order to measure the effect of disease management strategies on herd fertility. It was found that herders keep sick animals within their herds due to rational, economic reasons. Time and financial resources have been invested in each animal and selling a sick animal will result in a loss on that investment. Additionally, the prevalence of Brucellosis does not have a negative impact on herd fertility.

## **SUMMARY**

The broader context and purpose of this study was to better understand the interaction between human behavior, transmission of infectious diseases, the environment, and human and animal health. The results of this study underline the complexity of infectious disease ecology and contributes to the fields of anthropology, both veterinary and human medicine, and public health.

## **INTRODUCTION**

How infectious diseases move through and between communities and to what extent they impact the lives of those that are infected with them is influenced by a myriad of factors. Biological characteristics of the disease itself, the presence or absence of necessary vectors,

climate, seasonality, population density, human behavioral patterns, stigma, amount of knowledge available about the disease, and nutrition are just some of the factors that shape the ecology of infectious diseases. Some of these factors are easily measured and quantified and some are not, but all play some role in producing the total outcome that can be observed. (Funk et al, 2010)

Zoonotic diseases, or diseases that are spread between humans and animals, add additional pieces to the puzzle and as a category, include some of the diseases that cause the most problems for humanity. Human Immunodeficiency Virus (HIV) is believed to have been introduced into the human population after crossing species lines from a non-human primate in West Africa (Gao et al, 1998) and since its discovery in 1981 has been responsible for the deaths of 25 million people globally (UNAIDS Global Report on HIV/AIDS 2010). The H1N1 or ("Swine Flu") pandemic of 2009-2010, which killed over 18,000 people, demonstrated how rapidly zoonotic diseases can mutate and spread.

Previously published literature on African pastoralist systems describes the long-term goal of pastoralists to be the health and longevity of their herds. Many of these pastoralist systems are uniquely adapted to a highly unpredictable environment, especially in the Sahelian region. Climate change has only exacerbated the uncertainty of weather patterns, and major droughts in the region have increased in frequency since the late 1980s. (Dai *et al.* 2004)

Pastoralists' expert knowledge of animal husbandry and of their physical environment allows them to go beyond simply reacting appropriately to dramatic shifts in weather and food availability but rather utilize this unpredictability as strength. (Behnke *et al.*, 1993; Schareika, 2003; Krätli & Schareika, 2010) In his description of the cattle-breeding system of the

WoDaaBe of Niger, Krätli details the how the breeding system is not only devoted to ensuring genetic diversity but also to ensuring that cattle behavior necessary for survival, such as selective feeding on the most nutrient rich grasses, is passed down from generation to generation. (Krätli, 2008) Healthy longevity of the herd is important because herds are passed down from generation to generation and the survival of the next generation of humans is dependent upon the health of the next generation of cattle. (Mace, 1993; Stenning, 1958; Krätli 2008)

But seemingly in direct opposition to this goal, researchers have found that pastoralists in the Far North Region do not always remove chronically sick animals from their herds even though these animals may be infected with diseases endemic in the area that can potentially cause decreased herd fertility (Kunda et al., 2010; Scolamacchia et al., 2010). Brucellosis, for example, which is one of those infectious diseases, is highly contagious and can negatively impact herd fertility through causing spontaneous abortions, weak offspring, and/or lowered milk production. (Kunda et al., 2010; Scolamacchia et al., 2010) Brucellosis, which causes Undulant Fever in humans, directly has an impact on human health.

The objective of this research project was to understand the pastoralists' understanding of animal disease and fertility, and the rationale beneath the apparent paradox that emerges between the long-term goal of pastoralists (healthy herd longevity) and the observation that despite possible risk to herd fertility and production, African pastoralists do not always sell chronically sick animals. Specifically, two main questions were set out to be answered: why do herders keep sick animals within their herds, and consequently, how does the retention of sick animals within the herd impact herd fertility?

The ethnographic approach, i.e. striving to understand the pastoralists' system from their own point of view and in their own words (Bernard 2006), allowed the study to be successful in understanding the reasons why herders choose to keep sick animals within their herd and the decision-making process that leads up to the decision to keep or sell a chronically sick animal. The comparison of fertility statistics collected from each herd and Brucellosis prevalence samples collected in the previous two years successfully allowed the study to measure the impact that Brucellosis may have on herd fertility, in addition to the other multiple factors (including other diseases) that affect overall herd fertility.

This study was conducted within the broader, interdisciplinary research of the Disease Ecology and Computer Modeling Laboratory (DECML) at the Ohio State University. Comprised of members from the fields of anthropology, veterinary medicine, public health, and geography, DECML's main focus is studying the spread and persistence of infectious diseases between people and animals in the Far North Region, Cameroon.

## **Population and Study Area**

Pastoralists use animals both as a subsistence method and as an anchor for their identity as a group. Because they spend the majority of their time in close proximity to their animals, they are also a people for who zoonoses, such as Brucellosis, bovine tuberculosis, and leptospirosis, pose a high risk to both human and animal health. (Scolamacchia, 2010) Furthermore, even diseases that cannot be transmitted between people and cattle have the potential to greatly

impact the lives of pastoralists through decreasing their animals' nutritional and economic outputs on which they depend. (Schelling 2002; VanLeeuwen et al., 2012)

The pastoralists sampled in this study were comprised of both mobile and sedentary herders living in the Far North Region, Cameroon, in West-Central Africa. The mobile herders were comprised of both Arab and FulBe (subgroups: Jamaare'en, Mare'en, Alijam'en, Adanko'en, Anagamba'en, and Uuda'en) ethnic groups. (Ewing et al., in progress, 2012) FulFulde is the main *lingua franca* of the region. In addition to keeping cattle, smaller numbers of sheep, goats, horses, and donkeys are also utilized for either food and/transport.

The Far North Region is part of the transitional, Sahelian region that stretches across Africa between the Sahara Desert and equatorial Africa. The climate is semi-arid, with one rainy season that lasts about four months (roughly June-September). During the eight-month dry season (October-May), mobile herders are located in the Logone Floodplain (or *Yaayre* in Fulfulde) near the Chadian border. The sedentary herders were all located within a two-hour's drive radius from the region's capital city, Maroua.

### **Fulfulde and Biomedical Disease Taxonomy**

Because the study is ethnographic in nature, diseases and symptoms were discussed using Fulfulde terminology/taxonomy. While the pastoralists' disease taxonomy and biomedical disease taxonomy don't necessary overlap completely, based on the symptoms provided by the herders and traditional translations (Noye 1989; Tourneux 2007), the Fulfulde name and its most-likely biomedical name for the most commonly discussed diseases are as follows: *awse/*

trypanosomiasis, *baakale*/Brucellosis, *mboru/njobu*/foot-and-mouth disease, *haahande*/heartwater, and *sondaru*/cough. (Moritz et al. 2012) While the nature of this study is not biological, it is worth noting the origin types of each of the main diseases discussed. Brucellosis is a bacterial infection, foot-and-mouth disease a viral infection, and trypanosomiasis is caused by a trypanosome.

## METHODS

The methodology used in this study was ethnographic as one of the main goals of the study was to understand the models of disease and fertility and how this shaped pastoralists' decision-making process in deciding on if and when they will sell a chronically sick animal. A semi-structured interview (described in greater detail below) was conducted with a total of twenty-one herds over the course of nine weeks in January and February of 2012. Each interview was recorded using a Livescribe pen and with permission of the herder. The interviews were conducted either early in the morning before the herder went out to pasture with his herd or in the evening after the herd had returned for the day. If necessary, the interview was conducted in two sessions in order to accommodate the herd's schedule or the herder's level of fatigue.

Interviews lasted anywhere from 40 minutes to 150 minutes depending on the size of the herd and the herder's willingness to give ample details of his herd's fertility and disease status. The interview was written in English (the researcher's native language) and interpreted into Fulfulde (or in two cases, Musgum) with the help of an interpreter, a MA student at the

University of Maroua, who has several years of experience working with researchers. The same interpreter was used for every single interview.

The 21 herds were selected from the 30 total herds already enrolled in DECML's larger study of the transmission patterns and persistence of foot-and-mouth disease in the Far North Region. These herds were selected because of accessibility and the herders' familiarity of working with researchers. Within the total sample, 11 of the herds were sedentary and 10 were mobile. Herds from both variations of pastoralism were selected in order to assess whether or not differences in disease management and herd fertility exist between the two subgroups.

The sedentary herders were interviewed first, all during the month of January, and the mobile herders were interviewed in late January and February. The 21 herds were selected from the 30 in the DECML program based on their geographic accessibility and availability for when the interview could be conducted. The order in which the herds were interviewed was based on the most simple, logistic route that could be conducted with each trip out to the bush.

The semi-structured interview was divided into four sections, each being devoted to assess a different aspect of the research subject. The first section took advantage of the practice of the calf rope (each family keeps calves under the age of 12 months on a calf rope during the morning and evening in order to control their access to their mother's milk) as a ready-to-use heuristic tool to gauge the fertility of the herd in the past year. Questions about the age, sex, and the general health of each calf, in addition to questions about the age, reproductive history, age at first calving, and general health of each calf's mother were asked in order to assess a sample of the reproductive health of the current generation of females.



The second section was devoted to questions regarding how herders react to sick animals within their herd and how many sick animals they currently have, chronically or otherwise. Herders were asked to describe everything that they do for sick animals, about their methods of administering care, drugs used, if any traditional methods are also used, and how they know when they can stop administering treatments. If possible, the herder was asked to name and describe the health issues of each sick animal that they had in their herd in order to assess the diseases that are most frequently dealt with in the region. Each herder was specifically asked about whether or not they had experienced issues with Brucellosis in their herd.

The third section dealt with how animals are sold. The herders were asked to name each animal sold in the past year (if possible) or at least estimate the number of animals sold and for what economic need or reason was each animal was sold. Questions regarding how herders chose what animals to sell were also asked in addition to the direct question of whether or not a herder had ever sold sick animals.

The fourth and final section covered questions about how herders manage the fertility of their herd. The herders were asked about how they know their cows are pregnant and if they give any special treatment to pregnant cattle. Herders were also asked questions about fertility issues in their herd during this portion of the interview such as how many abortions had occurred in the past year, if they had any cows that were having a hard time getting pregnant or carrying a pregnancy to full-term, and what would they do with a cow that was beyond the usual age of first calving but had yet to give birth. In order to assess how or if herders make a connection between disease and fertility, they were asked if they believed that disease can

cause abortions and if so, name all the diseases that can. They were also asked hypothetically about whether or not they would be concerned about a neighboring herd's problems with an abortion storm spreading to their herd in order to understand the system of knowledge in place about the transmissibility of diseases.

After each interview was recorded, it was transcribed line-by-line. Using grounded theory, the each interview transcription was analyzed by the researcher and codes developed based on the responses given by the herders. These codes were sorted and organized into larger analytical memos that allowed the researcher to reconstruct the cultural models in place within the population. Differences in the frequency of certain codes allowed for the assessment of variation of disease management and concepts of the relationship between disease and fertility within the population and between the mobile and sedentary subgroups.

Demographic information taken from the each family's calf rope allowed for a creation of the fertility profile of the sample, such as the total year-over-year herd growth (calculated by dividing the current total number of cattle by the number of cattle minus the number of calves born in the past year), the average number of total cattle per herd (male and female, adults and juveniles), the average number of cattle born year-to-date, the average age at first calving, the average number of calves born to each cow, and the average number of abortions experienced per cow.

Colleagues from the DECML group collected biological samples testing the seroprevalence of Brucellosis in all thirty herds for the two previous years (2010, 2011). The prevalence figures were compared against the fertility figures collected from the calf rope portion of the semi-structured interview in order to assess the relationship between fertility

and Brucellosis prevalence. Unpaired t-tests were used to compare both the average herd fertility rates for both the mobile and sedentary herds against one another and the Brucellosis prevalence rates of mobile and sedentary herds against one another. A linear correlation test with confidence intervals of 95% was run comparing the overall fertility rates of all the herds in the sample against the average Brucellosis prevalence of all the herds in the sample.

## RESULTS

### Calf Rope and Brucellosis Statistics

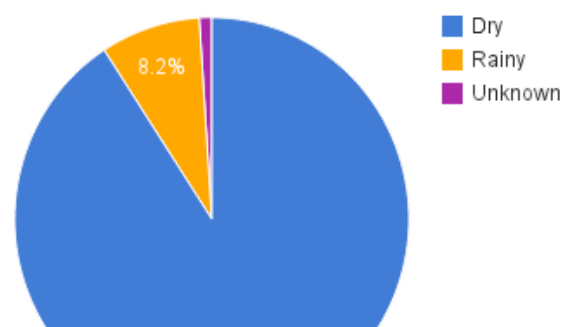
Between the 21 herds that were sampled, the health history of 105 calves and the general and reproductive health history of their mothers were assessed for a total of 210 individuals. Each family had an average of 5 calves currently on the calf rope, with mobile herders tending to have more calves (average of 7) than sedentary herders (average of 3). The standard deviation of the number of calves on the calf rope was similar for both subgroups; mobile herders having a standard deviation of 4 calves, sedentary, 3 calves.

The youngest calf was just minutes old (researcher witnessed the birth upon arrival at the camp) and the oldest calf was 336 days old. The average age of calves on the calf rope was 58.76 days, with a standard deviation of 58.18 days.

The large majority, 91%, of the calves had been born in the dry season and 8% born in the rainy season.

The remaining 1%'s season of birth was unknown

Season of birth for calves born YTD



because they had been bought at the market with their mothers. Females slightly outnumbered males, 54.08% of all the calves discussed were female.

In terms of health, the majority of the calves (81, or 82.65%) were reported to be in good health and/or currently healthy. The main health concerns discussed with the calves in poor health (listed in order of frequency) were: diarrhea, *awse* (trypanosomiasis), and *njobu*. Skin conditions, poor appetite, lack of milk/hunger, and maternal death/rejection were also mentioned but rarely.

The mothers with calves on the calf rope were on average 7.88 years old, with sedentary mothers being older on average (9.12 years) than mobile herd mothers (6.65 years). The average age at which all of the cows within the 21 herds sampled gave birth to their first calf was 4.8 years old. The difference in average age at first calving between the sedentary and mobile herds was slight (5.02 years vs. 4.58 years) but the standard deviation among the sedentary cows was much higher with a plus/minus range of 1.4 years (mobile herds was only 0.49 years).

Table 1: Descriptive statistics of mobile and sedentary herds

	# of total cattle	# calves on rope	#of calves born YTD	AVG age (days) calf	AVG age (years) mother	AVG age (years) 1st calving
<b>Total Sample</b>	<b>1042</b>	<b>105</b>	<b>215</b>			
<b>Average</b>	<b>49.6</b>	<b>5</b>	<b>10.2</b>	<b>64.60</b>	<b>7.88</b>	<b>4.80</b>
<b>STDV</b>	<b>33.9</b>	<b>3.7</b>	<b>8.0</b>	<b>69.17</b>	<b>2.95</b>	<b>1.40</b>
<b>Total SED</b>	<b>454</b>	<b>38</b>	<b>61</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Average SED</b>	<b>41.3</b>	<b>3.5</b>	<b>5.5</b>	<b>80.46</b>	<b>9.12</b>	<b>5.02</b>
<b>STDEV SED</b>	<b>38.3</b>	<b>2.9</b>	<b>4.4</b>	<b>93.80</b>	<b>3.55</b>	<b>1.40</b>
<b>Total MOB</b>	<b>588</b>	<b>67</b>	<b>154</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Average MOB</b>	<b>58.8</b>	<b>6.7</b>	<b>15.4</b>	<b>48.74</b>	<b>6.65</b>	<b>4.58</b>
<b>STDEV MOB</b>	<b>27.4</b>	<b>3.9</b>	<b>8.1</b>	<b>27.28</b>	<b>1.57</b>	<b>0.49</b>

Reproductively, including to the 105 calves currently on the calf rope, the combined number of calves born to all the mothers was 215. On average, each cow had given birth to 2.14 calves over the course of her lifetime. There were more first time mothers (heifers) in the

sedentary herds than in the mobile herds, resulting in a slightly lower average calf-per-cow (2.09) in comparison to the mobile herd average of 2.16 calves-per-cow. The amount of pregnancy failures due to abortion was very low for the whole sample and for sedentary and mobile herds individually. Only three abortions were reported amongst all the cows surveyed, two among the mobile herds and one among the sedentary herds. The average abortion rate was exactly the same in both subgroups: 0.03 abortions per cow. Calf mortality was most affected by calf deaths that occurred between the ages of one week and two years. When the number of abortions and calf deaths were combined, the whole sample had a calf mortality rate of 16%. Calf mortality was slightly higher among the sedentary herds (17%) than among the mobile herds (16%).

At the time the interviews were conducted, 14% of all the mothers surveyed were reported to be currently sick. There was a large difference in the general health status of mothers between the sedentary and mobile herds: 18% of sedentary mothers were reported to be currently sick while only 10% of mobile mothers. Two main diseases were mentioned when discussing the health problems of the currently sick mothers: *awse* and *njobu, mboru*. Many times herders could not specify a specific disease and the cause was marked down as “unknown”. Injuries of various sorts, such as a broken leg, were also reported. These animals were still marked down as sick solely because they were not healthy.

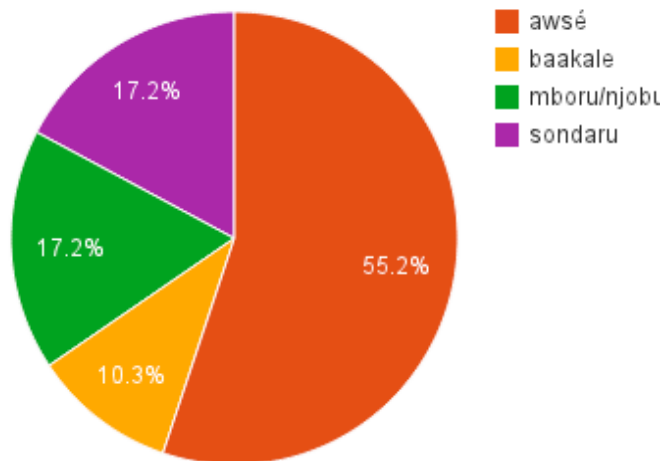
### **Pastoralists’ Models of Disease and Fertility**

Not surprisingly, the herders sampled view animal disease as a major threat to their livelihoods. Herders actively try and limit the impact disease has on their herds, using a wide range of prophylactic techniques such as lighting smoke fires at night to keep away flies and other biting insects and placing leather amulets around the horns of some animals to protect the entire herd from disease and thieves. Other researchers have detailed techniques such as these as well. (Ba 1994, McCorkle 1986) Veterinary medicine, whether appropriately or not, is at times administered in a prophylactic manner sometimes at regular intervals throughout the year. This occurs in addition to the biannual vaccination schedule that is mandated by the Cameroonian government. At one camp, a small calf was even observed to be wearing a cape of cloth tied around its neck, which when asked its purpose, was to prevent flies from “disturbing the animal”.

Furthermore, herders throughout the population make a connection between animal disease and fertility issues, such as abortion. When asked about a link between disease and abortion, all herders interviewed overwhelmingly agreed (95.23% of all interviewed) that it is possible for disease to cause abortions in cattle. Only one herder answered the question “Is it possible for diseases to cause abortions?” with “It’s possible but I don’t know for sure.” When asked to name the diseases or situation that they knew could cause abortions in cattle, the answers were more varied. *Awse*, flies/fly bites, *njobu*, *mbooru*, *baakale*, *mboodi*, *haahande*, illness of the spleen, and being “beat with a stick”, were all given as potential causes for abortion in cattle. There were also three herders who said that disease could cause abortions but couldn’t tell describe any specific disease. One herder mentioned that any disease “if very strong” could potentially cause an abortion.

[Insert chart w/% of most frequently mentioned diseases]

**Most frequently listed current diseases**



As can be seen in chart #, while *baakale* is frequently mentioned as a disease that can cause abortions in cattle, it is not the number one preoccupation of the herders. By far, *awse* was the disease that garnered the most concern from

herders. This is understandable when one considers that the source of *awse* (biting flies/fly bites) is much easier to connect to the presence of the disease than *baakale*, of which the source (bacteria) is invisible to the naked eye.

While there is a near consensus in the population that disease and fertility are linked, there does not seem to be a consensus on how diseases are spread from herd to herd. The herders were hypothetically asked, "If a neighboring herd experiences an abortion storm, will you be worried about it affecting your own herd?" Overall, the entire sample population was nearly divided: 55% said that they would be worried about the abortion storm spreading to their herds. Concern was slightly greater among the sedentary herders, 60% of whom said that they would be worried while only 50% of the mobile herders mentioned that they would be concerned.

Herders who were not concerned often responded to the question with answers such as "No, I will not be worried because it [abortion storm] is not contagious. Unlike *bumsude*,

*mbooru*, or swelling. Those I will be worried but abortion storms, no.” Of herders who did express that they would be concerned, some expressed a level of defenselessness against disease saying, “I will be worried but do nothing.” While others said that they would do whatever possible to separate and keep their animals from mixing with the affected neighboring herd and some even mentioned that they would also give veterinary drugs prophylactically.

### **Treatment of Sick Animals**

During the semi-structured interview, herders were also asked to list the number of currently sick animals that they had in their herd as a whole. Their reported numbers can be seen in Chart # below.

[Insert Excel spreadsheet @ sick animals]

Of all the chronically ill animals discussed throughout the entire sample, four diseases were mentioned most frequently: *awse*, *njobu*, */mbooru*, *baakale*, and *sondaru*. *Awse* was mentioned almost four times as much as any of the subsequently listed diseases. There were also cases in which herders said they were unsure of what disease the animal had with unexplained weight loss being the symptom most often mentioned in conjunction with an unknown disease.



When herders were asked specifically if they currently or have ever had animals with *baakale*, 11 (55%) responded “yes”. Of the 11 who had had or currently had animals with *baakale*, only one herder said that the animal with *baakale* had had fertility problems (giving birth at full-term to a stillborn calf). Seven of the 11 answering in the affirmative were mobile herders.

The initial reaction to animal disease was consistent throughout the entire sample population. When asked “What is the first thing you do when you notice an animal is sick?”, all but one of the herders interviewed said that they would immediately administer veterinary drugs and that if they didn’t have any, would immediately go and buy some to administer to the sick animal. Only two herders (both sedentary) mentioned that one of their first actions would be to call a veterinary doctor, and then would give the animal veterinary medicine if that was what the doctor described.

A wide range of drugs is available to herders, both sedentary and mobile, for purchase at local markets or from traveling peddlers that move from camp to camp in the Yaayre. Traditional treatments are also sometimes utilized although to what extent varies from herder to herder. Despite the wide range of options in drug treatment options, four main drugs were mentioned over and over again throughout the entire sample: *oli* (FulFulde name referring to the yellow color of the drug, which is a trypanocide), *veriben* (*Veriben* the trademark name of another antitrypanosomal drug), *oksi* (oxytetracycline, an antibiotic), and *procayne* (*Procaine* brand name antibiotic). Herders were aware of the names of these drugs but not necessarily what type of drug it was.

When asked about how they know what drugs to buy and/or choose to use on a sick animal, 95% of the herders said that they would match the drug to the disease. This matching occurred both with and without the help of drug vendors or veterinarians. One herder responded "I know animal disease, so I know what drug to give for certain diseases." If they were unsure of what disease their animal had, 19% of herders specifically that they would ask the seller at the market what drug to buy after describing the symptoms of the sick animal.

In addition to using a disease-drug matching method, some herders chose a drug based on prior success and used it as a first line of defense against everything. For example, one herder mentioned that he used *oli* for everything. Because every herder's prior successes with certain disease-drug combinations are different, the favorite drug varied throughout the sample population. One herder said that he will always first use either *oxy* or *Procaine*. Several herders also employed a lottery-style approach to drug selection and would administer whatever they had on hand in hopes that it would work.

The time span and frequency of dosing also was highly variable throughout the entire sample population. The majority of the sample population was illiterate, and thus reading the dosing instructions on the package is not an option. When asked, "How do you know when to stop treatment for a sick animal?", most herders utilized a wait-and-see approach where they would administer the first dose of the drug, wait to see if the animal's health improved, and then either stop treatment (if animal improved), administer another dose, or change drugs (if the animal's condition stayed the same or worsened).

The style of the "wait-and-see" approach varied throughout the population. Some herders had a chronologically structured "wait-and-see" approach where they would

administer the first dose of a drug, wait a set number of days, then either change drugs or administer another dose if the animal's condition did not improve. Whereas others utilized a more intuitive "wait-and-see" approach using more observational clues (e.g. animal "has her strength back", "I can tell she has will to live back") to decide whether or not to administer more drugs.

Amidst the similar response in utilizing veterinary drugs as a first reaction to animal disease and the variation in how these drugs are selected and used, an interesting difference was noted between the sedentary and mobile herders. Mobile herders frequently mentioned the use of "fire" or cauterization as an option in treating animal disease, especially swelling. Some mobile herders were more likely to use it than others; one even said, "You can use fire to treat anything. Anything! Even stomach problems." But, fire was always mentioned as something that could be used either in conjunction with veterinary drugs or as an option for when veterinary drugs did not work. No sedentary herders mentioned the use of "fire" as a way to treat animal disease.

### **Selling Chronically Sick Animals**

Generally speaking, animals (sick or not) are not sold for pure profit but in response to an economic need. At no time did any herder mention selling any animal for presently unknown future expenses. To understand the pressures that precipitate an animal being sold, herders were asked about all the animals that they had sold in the past year, not just the sick ones.

Please refer to Chart # to view the percentages of animals that have been sold in the two groups.

The wide range in the percentage of animals being sold is better understood when the variation of pressures that cause herders to sell animals is taken into account. Among the sedentary herds, 43% of all animals sold were sold due to lack of cash. The cash was needed for a variety of reasons: pay for supplementary food for cattle, to pay for farm work, emergency cash to pay medical bills for a sick child, pay veterinary fees, pay legal fees, and to fix things around the house. The next largest economic pressure to sell animals was to pay for weddings and the preparation of the family for annual religious feasts, 16% (11 % religious feasts, 5% for weddings). Many of these economic pressures to sell animals can vary greatly from herder to herder and from year to year.

Only 16% of the animals sold were sold because they were sick. When asked about how they choose what animals to sell, most herders explained that it depended on what the economic need was. If they needed "big cash", they would choose to sell the biggest and fattest animal. If they only needed "little cash", they would sell either a young or very old animal. Typically, a sick animal was only brought to the market if there was no other suitable animal (i.e., a young or an old animal) to be sold.

Interestingly, there seems to be a stigma against selling sick animals, especially among the mobile herders. When asked, "Have you every sold sick animals?", overall 71% of the entire population sample said that they had sold a sick animal in their lifetime. But while 91% of sedentary herders said that they had sold sick animals in the past, only 50% of mobile herders said that they had sold sick animals. The other 50% said that they had "Never" sold sick

animals. Yet when discussing individual animals that they had sold in the past year, some of the herds that said they “never” sold sick animals mentioned that they sold animals that had been sick.

As can be seen in the hierarchy of selection in choosing which animals to sell (fattest, biggest for larger economic needs; youngest or older, for smaller economic needs- and then only sick animals when youngest or older animals not available), chronically sick animals are sold as a last ditch effort to recoup any economic investment that has been placed on them. From the semi-structured interviews, two main scenarios exist in which sick and/or chronically sick animals will be sold. The first is when the herder can tell that the animal is going to die in the very near future. “It is then when you rush them to the market to at least get some money!” Another option for terminally sick animals is for the herder to slaughter the animal himself (or hire a butcher) and sell/eat the meat. Despite the stigma against selling sick animals, when the researcher asked, “Do people really buy very sick animals?” it was explained that there are indeed people who buy very sick cattle from time to time because it is a source of “cheap meat”.

The second scenario in which sick animals are sold is when the animal has been chronically sick for an extended period of time and the herders “have done everything possible to try and heal them” but the animal keeps getting sick. In this scenario, the animal is not terminally ill, so the herder will wait until the animal looks as healthy and fat as possible and then take it to market.

### **Effects of Disease on Herd Fertility**

There was found to be a significant difference in the fertility rates of mobile versus sedentary herds, with mobile herds being more fertile even after the figures being adjusted absolute herd size. There was no difference in the treatment of diseases and the drugs most frequently used between mobile and sedentary pastoralists. The prevalence of Brucellosis was equally distributed throughout the sample population, with no statistical difference found between the prevalence of Brucellosis in mobile and sedentary herds (STATISTICS). Essentially, the amount of disease and reaction to the disease was found to be consistent throughout the sample population.

Because of the similar treatments of the disease and the prevalence of Brucellosis, disease management strategies and Brucellosis itself are not the greatest factors influencing the differences in herd fertility between mobile and sedentary herders. In fact, a surprising positive relationship was found between Brucellosis prevalence and increased herd fertility (STATISTICS). (Chart #) The nature of this relationship needs further investigation.

## **DISCUSSION**

The key findings of this study are that herders keep sick animals within their herd because of economic reasons. It is acknowledged that disease has an effect on fertility but not all diseases are regarded as equally dangerous. But the knowledge of how diseases that do affect fertility are transmitted is mixed. It was also found that there is little impact on the prevalence of Brucellosis on the overall fertility of the herd.

## Contributions

While pastoralism is a unique way of life that is becoming increasingly rare across the globe, pastoralists like all other human beings are involved in various ecologies, including ecologies of infectious disease. The conclusions drawn from this study can be easily generalized to other pastoralist populations because having to balance short-term goals (i.e. keeping sick animals to protect previously made investments) against long-term goals (i.e. creating a healthy herd for the next generation) is not unique to the Far North Region (Mace, 1993)

As McCorkle detailed in her introduction to the theory of ethnoveterinary research and development, it is important to understand ethnoveterinary systems holistically in order to create effective policies and animal production strategies that are appropriate and beneficial for both the target animal and human population. While it seemed irrational and paradoxical at first for herders in the Far North Region to maintain chronically sick animals, the conclusions of this study demonstrate that with just a little ethnographic investigation, the decision to keep sick animals with herds is very rational. The assumption that Brucellosis would greatly negatively affect herd fertility turned out to be incorrect and keeping sick animals makes more economic sense and does not risk the long-term goal of healthy herd longevity.

At the broadest level, this study was conducted to better understand how human behavior and decision-making in regards to disease and disease transmission affect the disease ecology within which they live. The “One Health” and “One Medicine” movements, which emphasize the need to see animal and human health problems as issues of one, integrated

system (Kahn *et al*, 2008; Schwabe 1984; and Zinstag, et al., 2005), advocate for interdisciplinary research like this study in order to understand every aspect of the human-animal health ecology.

### **Strengths of study**

Due to its ethnographic approach, the study's main strength in its description of the decision-making processes regarding animal disease and fertility that comes from the source (Bernard 2006). Spending up to two hours interviewing each herder allowed for the generation of a large amount of quality, descriptive data and a very deep understanding of how the herders view their own situation. It also enabled the study to measure the variation within the population. By utilizing the family's calf rope, the study was able to cull the most current quantitative data (within the past year), which is most likely to be the most accurate in terms of memory recall. By being on site with the herders in general, seeing and interacting with the animals, allowed for additional confidence in the reliability of data reported.

Constructing the semi-structured interviews with multiple sections that at times overlapped provided a built-in crosschecking system. This multi sectional approach also enabled differences in what people *say* they do and what they *actually* do surface, providing interesting cultural model details. For example, asking the herders to describe the condition of animals they had sold and then asking them directly if they have ever sold sick animals brought out that a stigma against selling sick animals exists. The partial overlap of section topics also allowed the study to gain fertility data on a sample of cows for the past year (calf rope



questions) and also a sample of fertility issues that go farther back in time (section on pregnancy and pregnancy issues).

Last, but certainly not least, the access to biological samples measuring the seroprevalence of Brucellosis taken in the previous two years allows the ethnographic findings of this study to be compared against biological findings to evaluate any relationship between the two ecological factors.

## **Limitations**

The study is not without its limitations. While a large amount of data was generated from the semi-structured interviews, it cannot be ignored that the sample size (21) is small. Also, while the research team spent up to three days with one herd, the amount of participant-observation was limited. It would have been interesting to be able to interview each herder then spend an extended amount of time observing his behaviors in action to see if any differences exist between what herders *say* they do and what is *actually* practiced day in and day out.

Also, while the main goal of the study was to better understand decision-making strategies and how the herders themselves view disease and fertility and not necessarily the absolute truth, because the main interviewer (myself) is an outsider, some instances of secretiveness did occur. For example, some herders were reticent to discuss how traditional treatments are created literally saying to me “I cannot tell you that because it is a secret”.

For economic reasons, there were also cases of herders underestimating the number (sometimes as much as 50%) of total cattle they own as they are supposed to pay a certain

amount in taxes per animal and did not have 100% trust that the numbers they gave the researcher would not be then given to tax authorities.

Having biological samples on Brucellosis shed light on the interaction between the behavioral and biological systems in place within the population but only in terms of one disease. Other diseases endemic to the area can potentially cause abortions in cattle and having prevalence samples for these, like *trypanosomiasis*, would have given a more complete picture on the relationship between human behavior, disease, and animal fertility.

Finally, the area experiences three distinct seasons: a hot, dry season; a cold, dry season; and a rainy season. Herders mentioned frequently throughout the interviews that disease varies seasonally and because the interview was only conducted during the cold, dry season, it is possible that some answers would vary if the interview was to be conducted during, for instance, during the rainy season.

### **Practical Implications and Future directions**

Despite the limitations of the study, the findings add to the knowledge bases in numerous fields. Within the anthropological field, it adds to the description of different subsistence systems throughout the world and variation in ethnoveterinary practices. For the biological sciences, it reminds researchers that disease transmission does not occur in a vacuum gives them cultural context in which various biological processes are taking place. For the public health field, it highlights the need to keep in mind that the ecology of disease has multiple

factors and that policies created in order to prevent and stem the prevalence of disease needs to be multifaceted as well.

Further investigation on this topic would need to involve a closer look at the other factors that affect herd fertility beyond disease management strategies. Studies involving evaluation of animal nutrition, immunology, seasonal effects of disease prevalence, and the prevalence of diseases other than Brucellosis need to be conducted in order to tease out the myriad of factors that affect disease transmission and herd fertility in the Far North Region and to try and evaluate the order of magnitude that each plays within the system as a whole.

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